Pseudo-flat lattice in Booster

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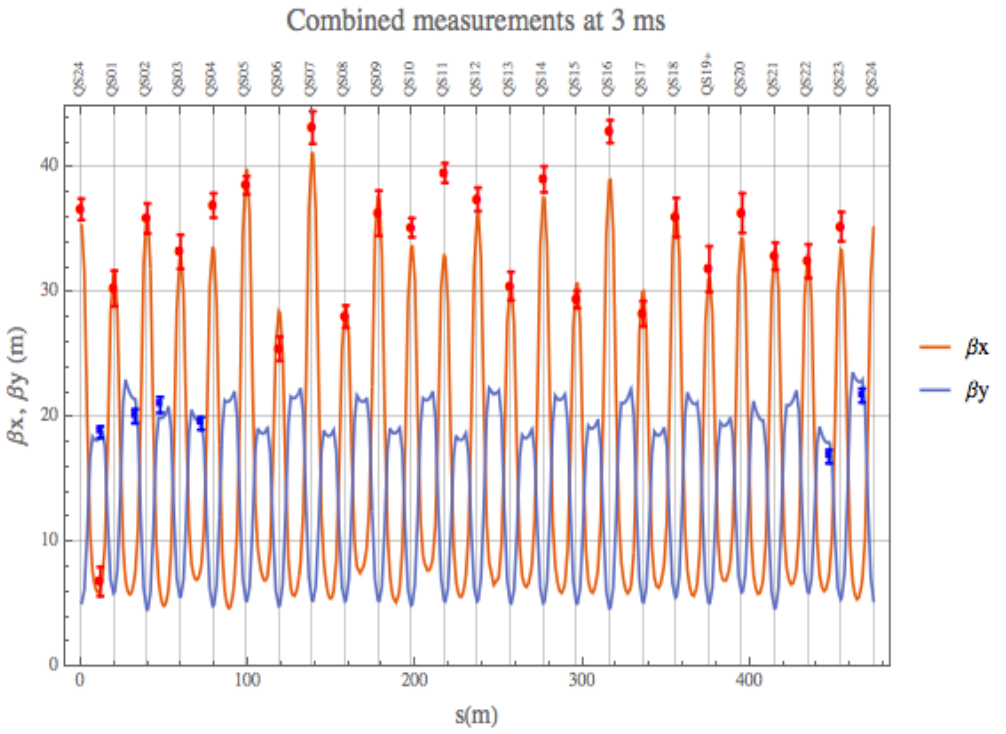
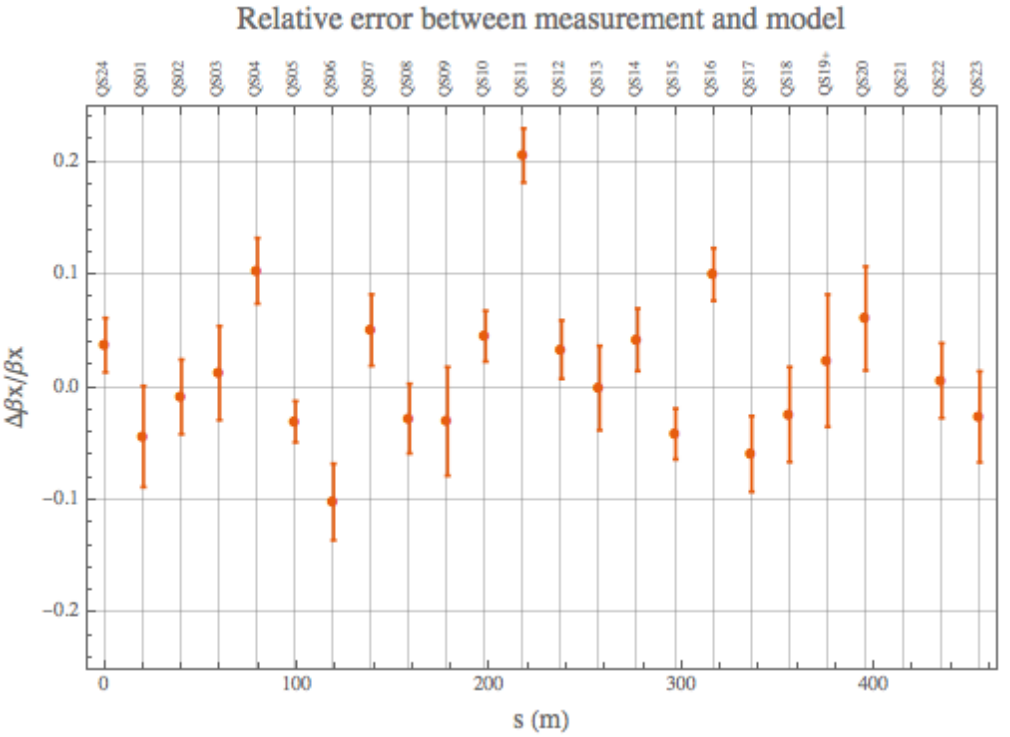
Goals for the past 2 weeks

- Create pseudo flat lattice in Booster
- Measure as loaded pseudo lattice with tune response method.
  - Check that measurements are “close” to model.
    - Expect +/- 10% type agreement.
  - Check orbits
    - Make sure that orbits are close to HEP orbits and the lattice is minimally affected.
  - Make tune scan to verify that tune space is unchanged or improved from HEP. (to be done)

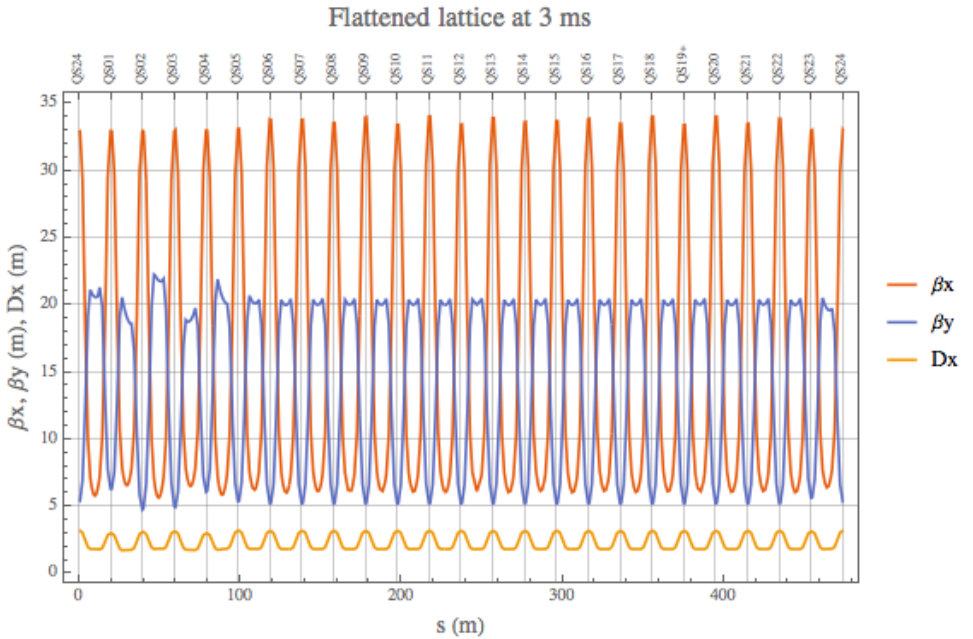
HEP lattice with measurements (Reminder)

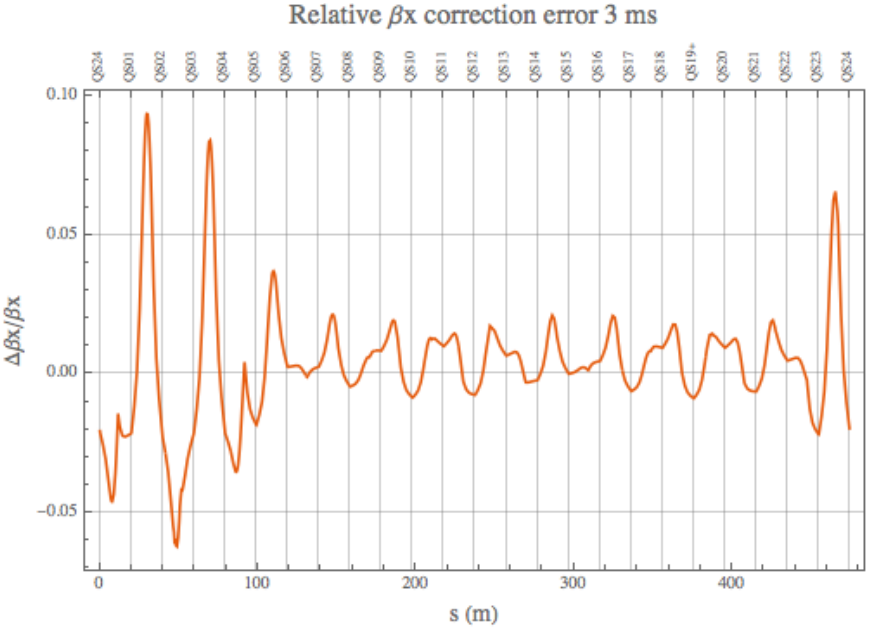


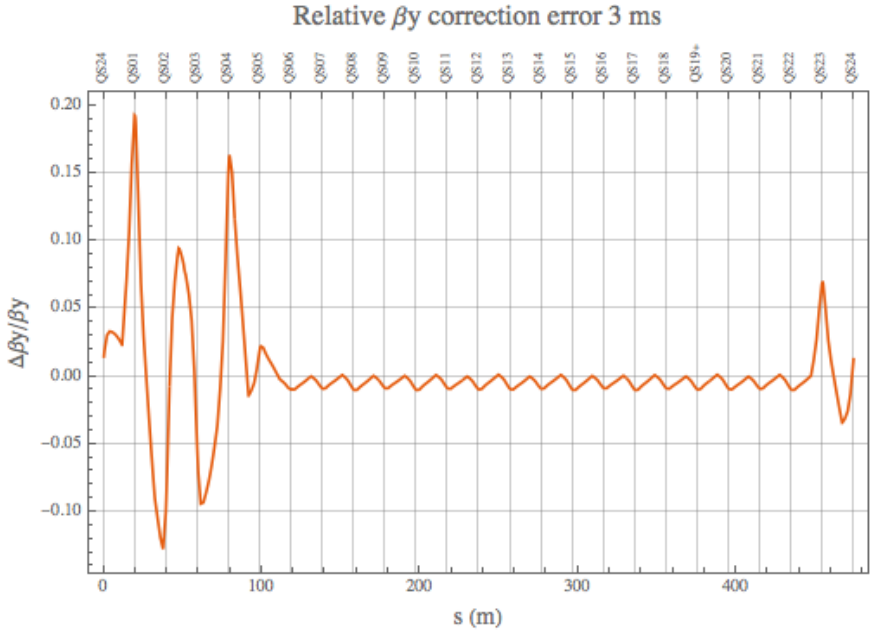


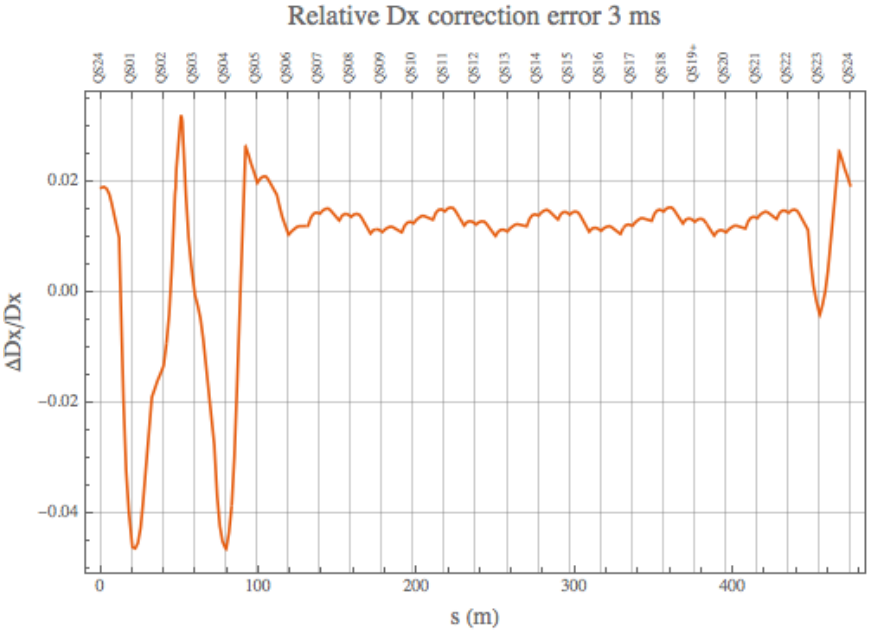
Measurements and model are within +/- 10% except at 1 location, QS11

Model pseudo-flat lattice





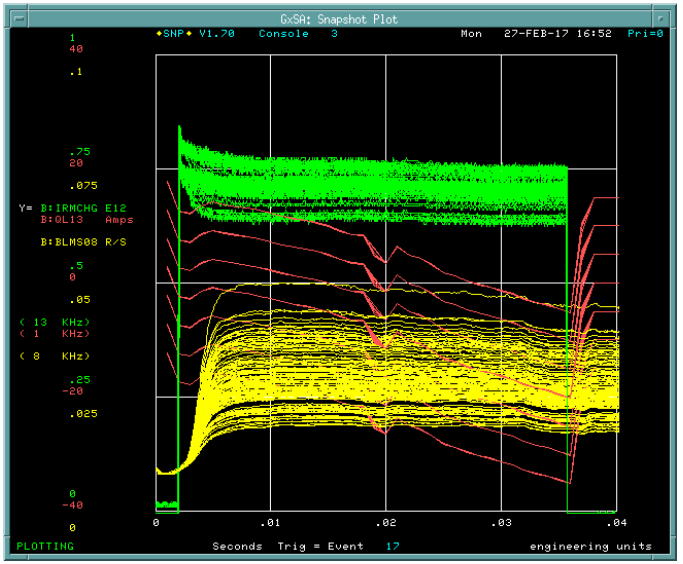


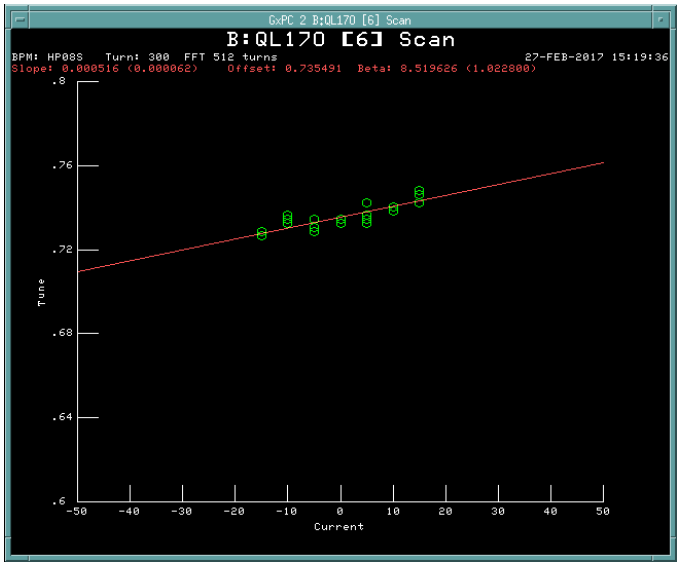


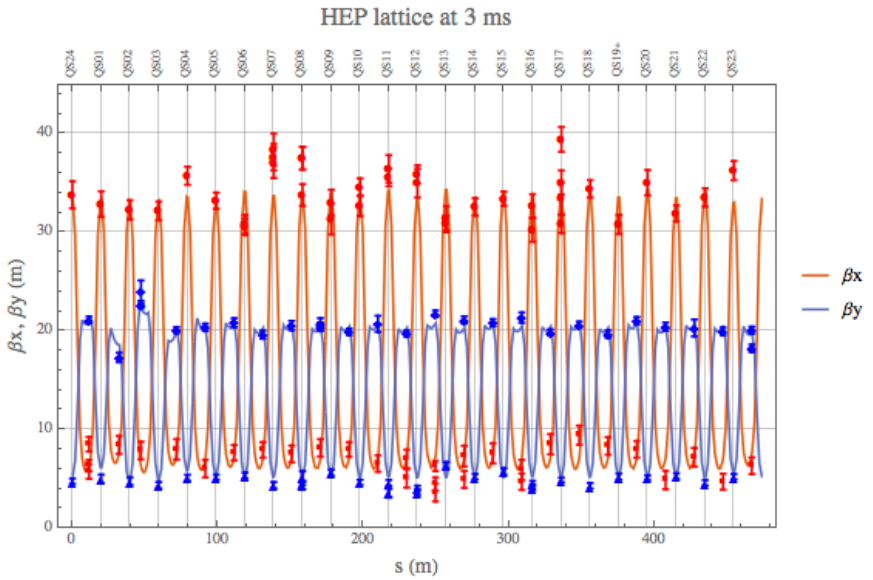
Measured data

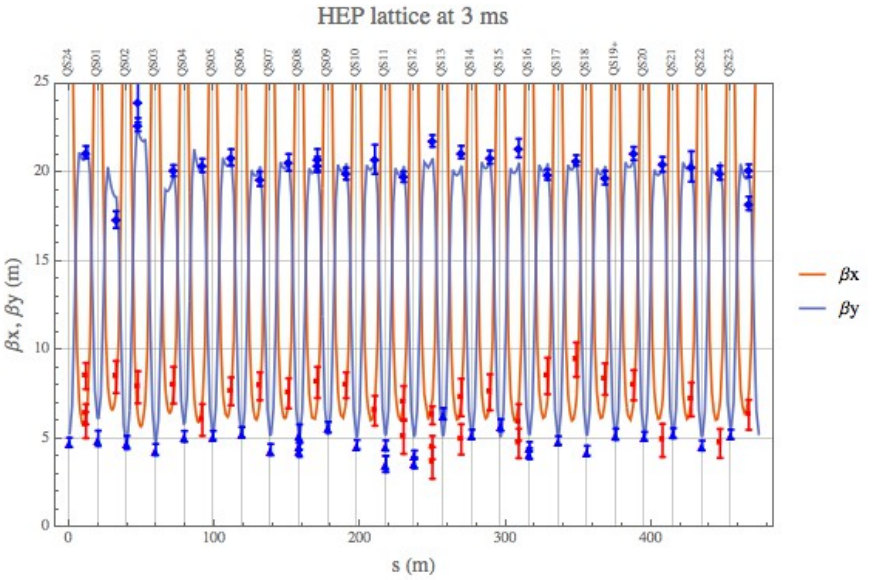
current=0.75e12

Horizontal tunes more noisy than vertical



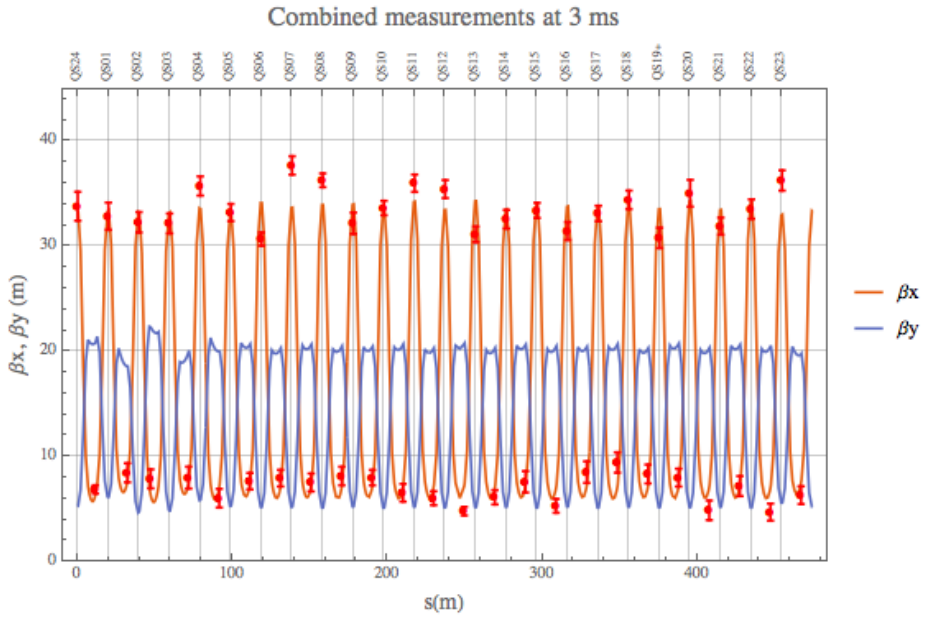


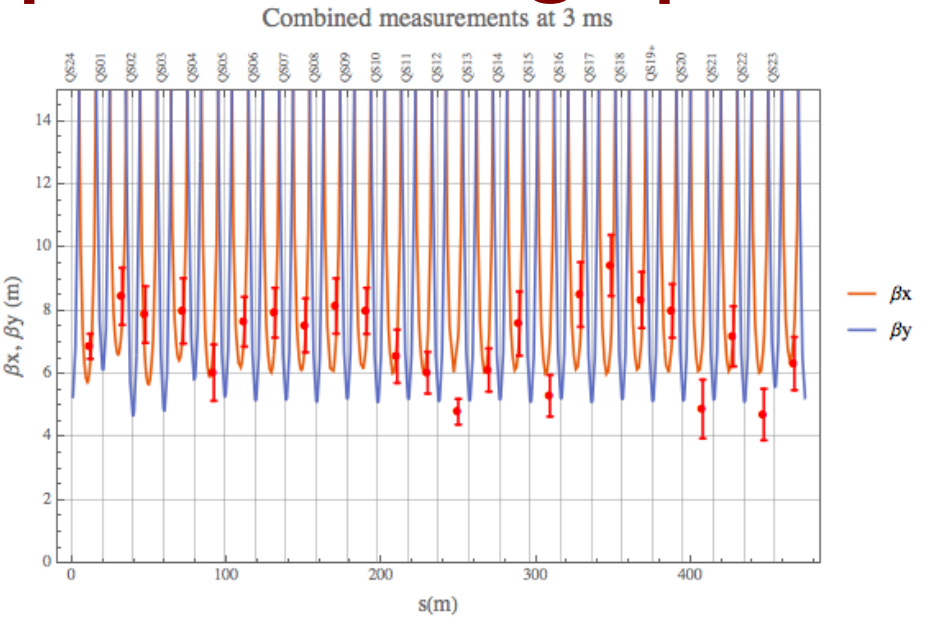


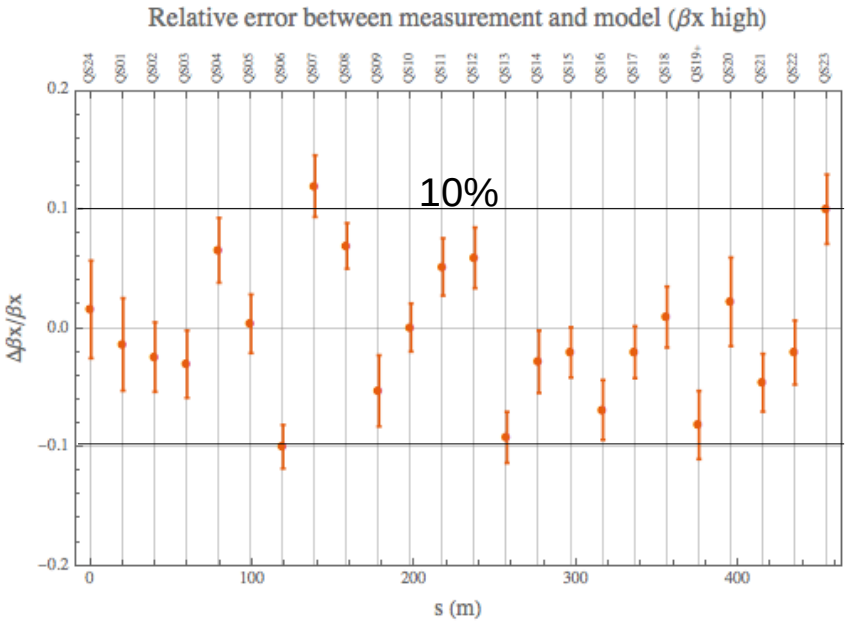


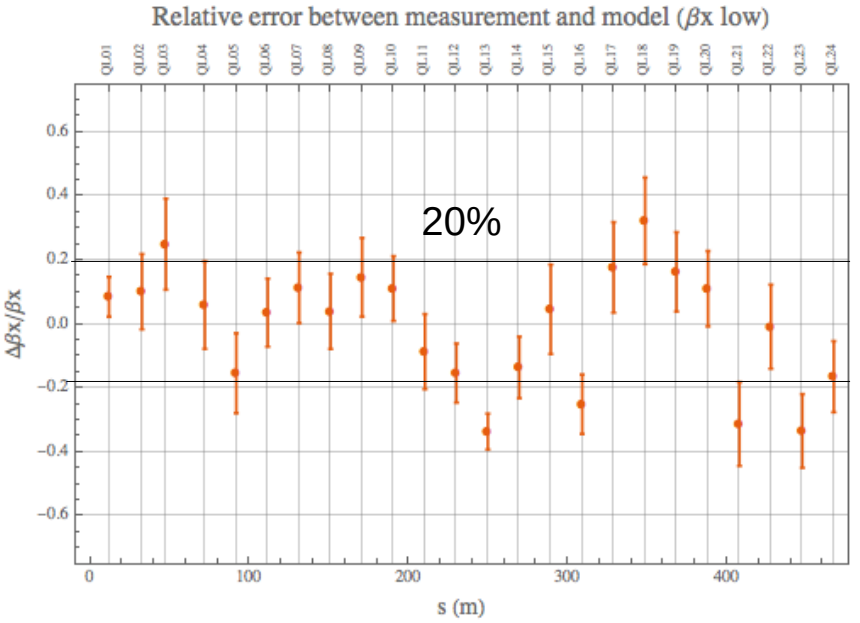
All the data points that we measured. Some multiple times.

After some data processing, βx

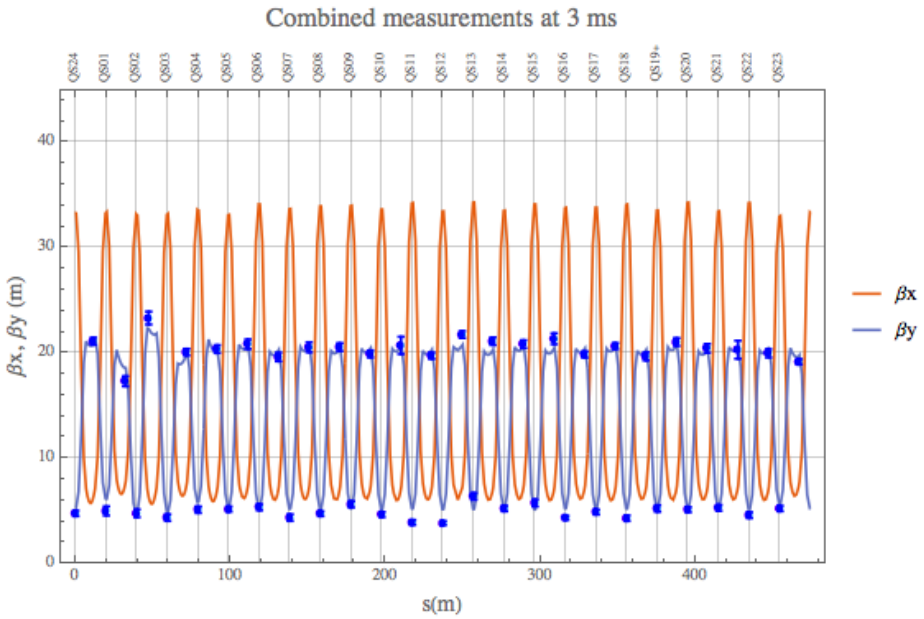


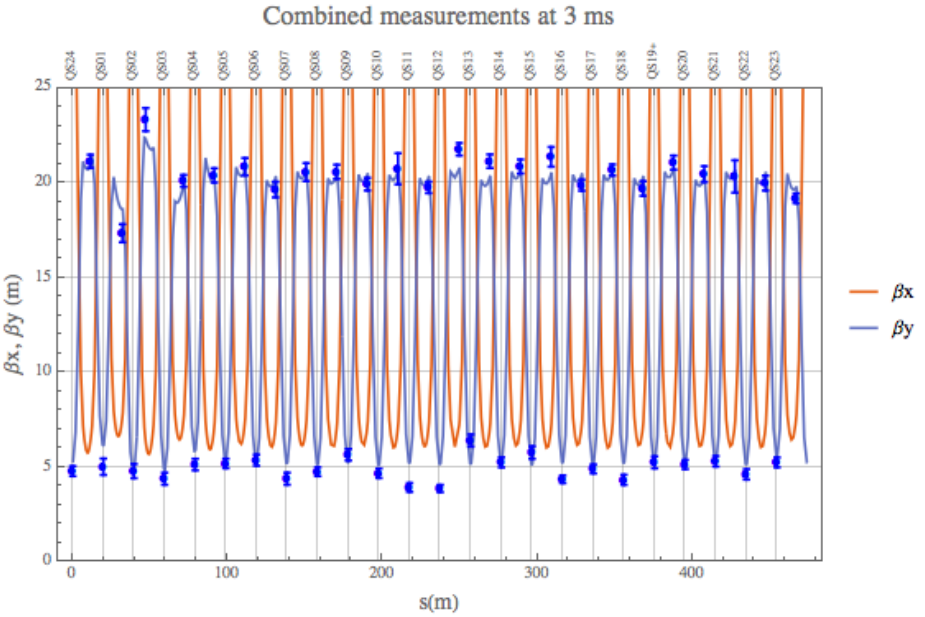






βy


Combined measurements at 3 ms
βx, βy (m)
s(m)
βx
βy


Combined measurements at 3 ms
βx, βy (m)
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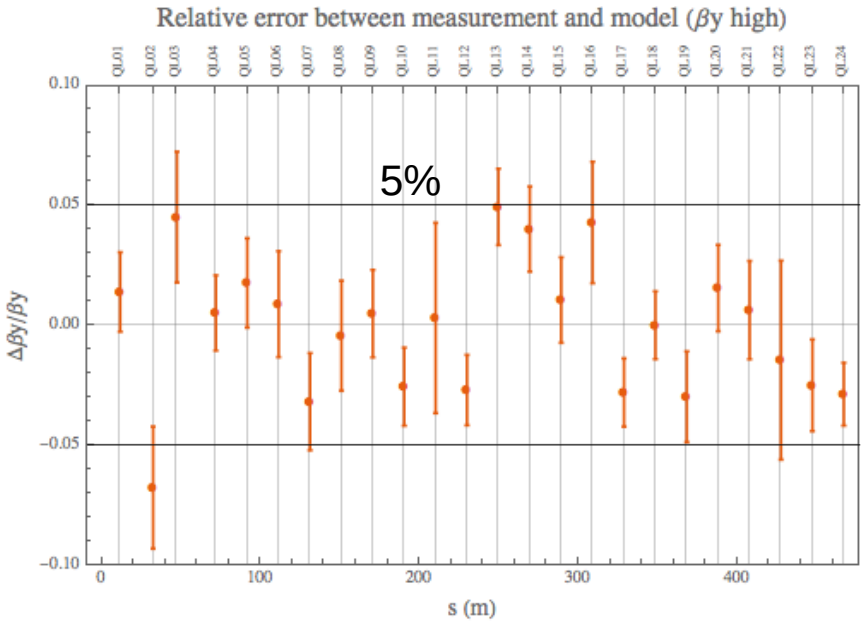
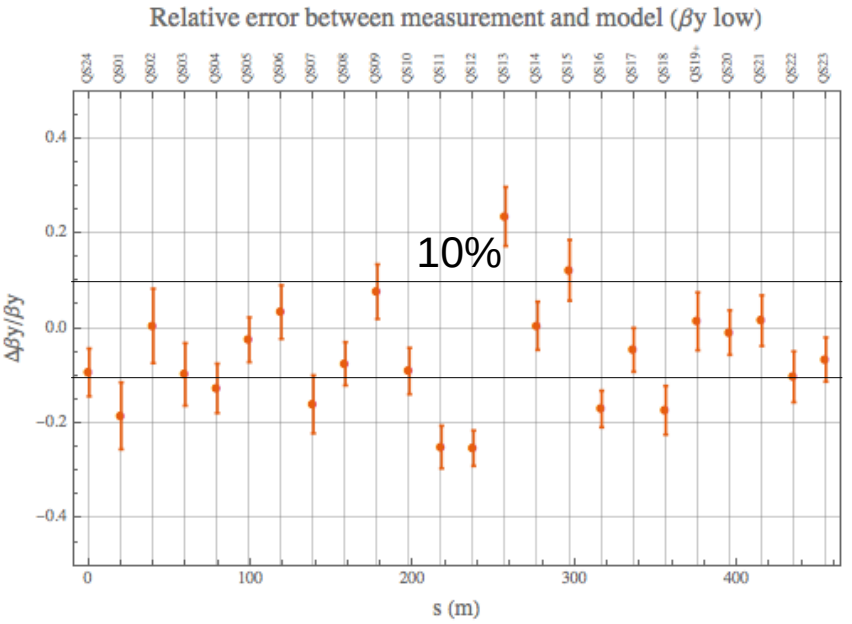
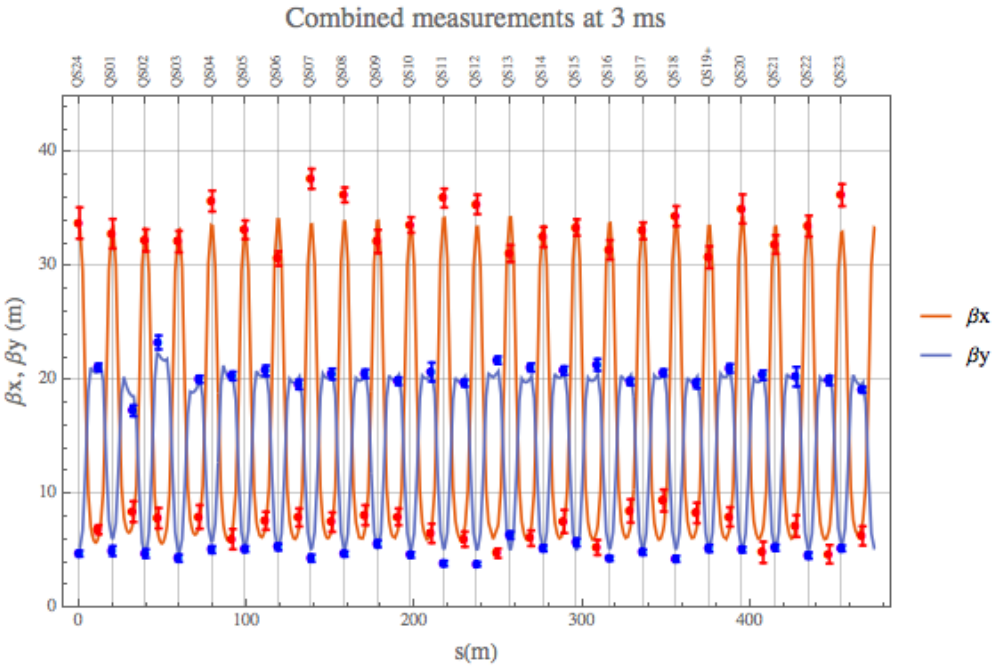
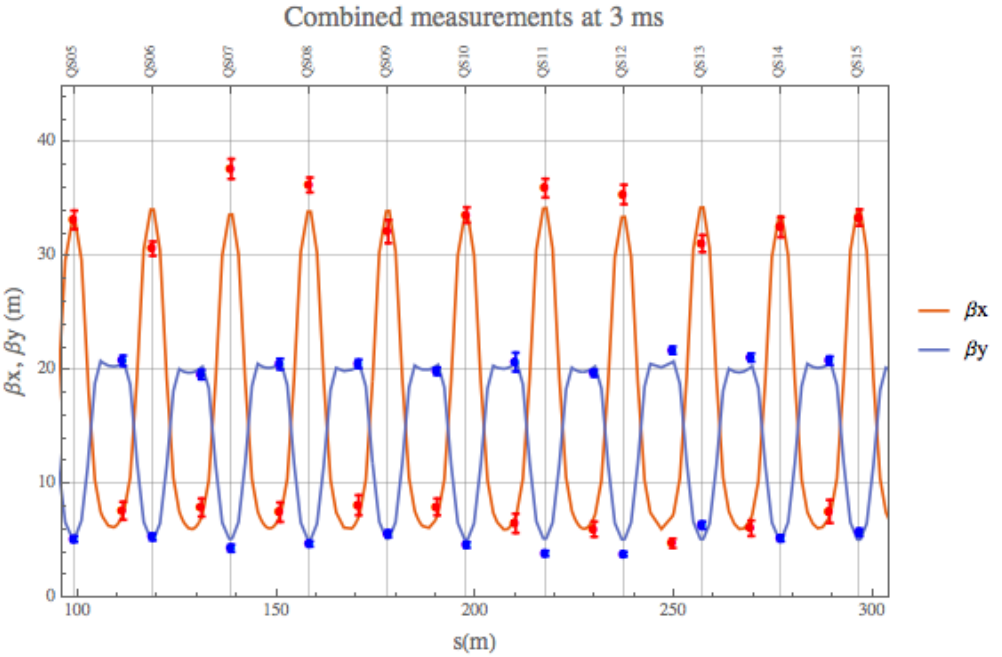
βx
βy


Relative error between measurement and model (βy high)
Δβy/βy
s (m)
5%


Relative error between measurement and model (βy low)
Δβy/βy
s (m)
10%

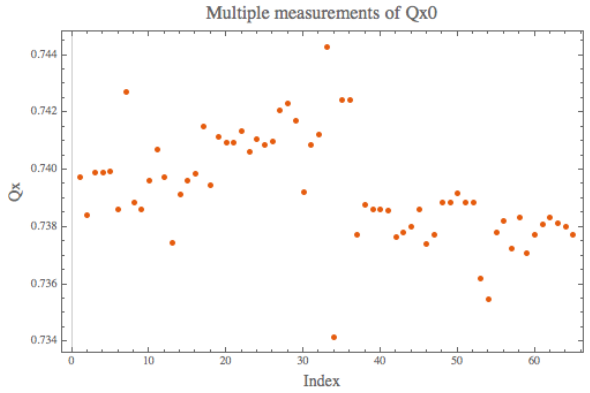
Interesting locations

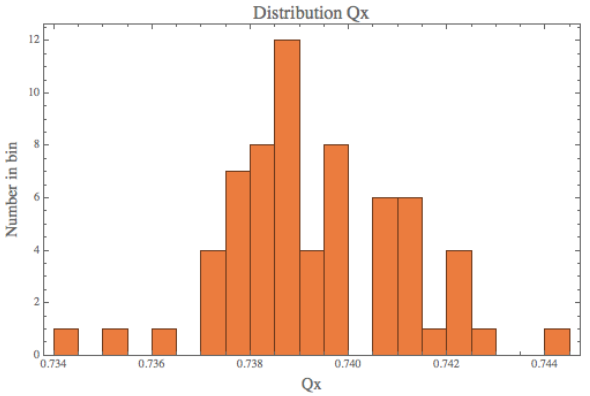


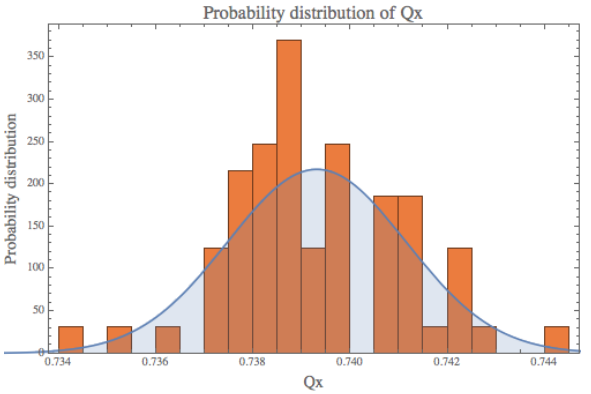


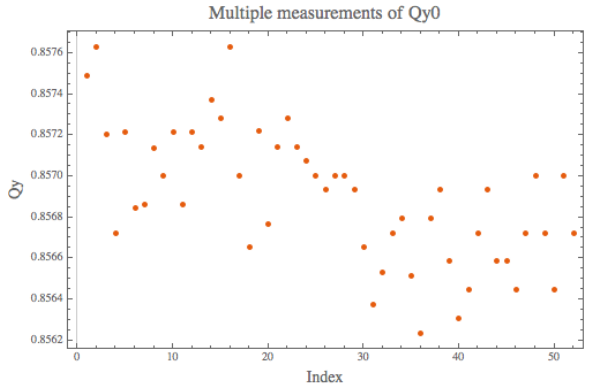
Interesting region starts from QS06 and ends at QS14.
Collimation region at L06 and absorber region at L13.
QS12 has horizontal ~1 cm offset.

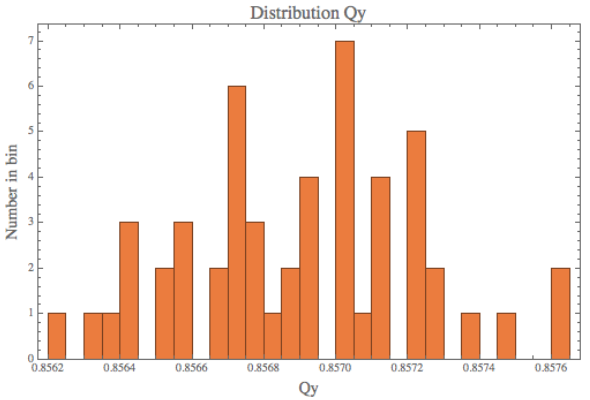
Checking tune measurement errors

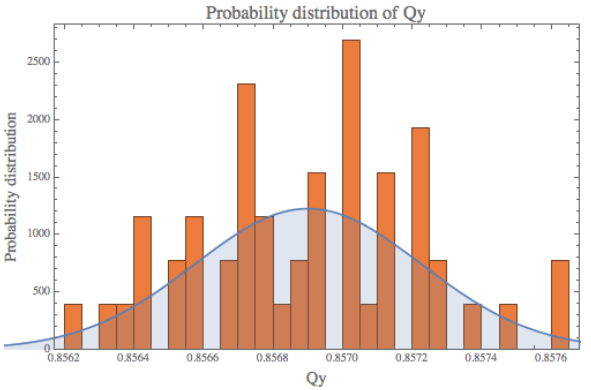








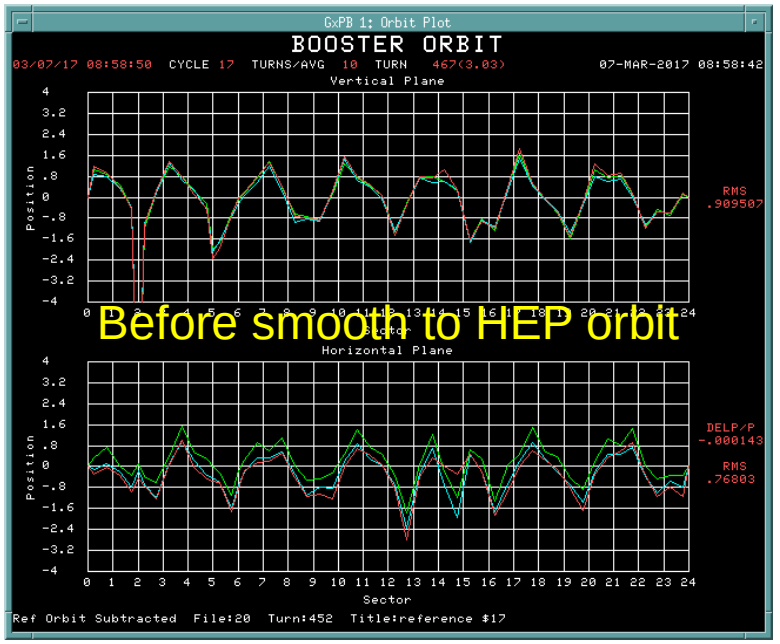




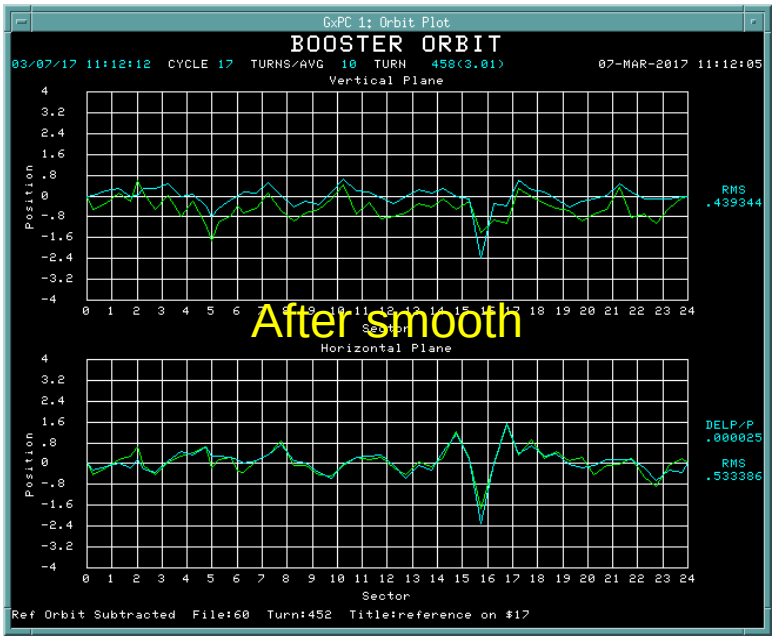
Qx0 = 0.739 +/- 0.002
Qy0 = 0.8569 +/- 0.0003

The above implies that:
σ βx = 1.1 m ← consistent with measured b error calculated from measured slope error
σ βy = 0.2 m ← factor of 2 smaller than b error calculated from measured slope error

Smoothing orbits to HEP orbits and checking interesting locations



Before smooth to HEP orbit



After smooth

Bumped out orbit bump at absorber.

The problem is that after we took out the bump, we had a very hard time measuring the tunes. Probably due to beam loss.

Inconclusive whether orbits causes lattice distortion at 11, 12, 13, 14.

Plans

- Complete tune scan for HEP and pseudo-flat lattice.
  - See whether tune space of pseudo-flat lattice improves or stays the same as HEP.
- Collect orbit response data
  - Use LOCO to calculate lattice. Compare with tune response data.
  - Calculate dispersion orbit response data.
- Tune the machine to improve efficiency at low intensity.
  - If cannot improve to at least the same efficiency as HEP lattice then something is wrong and we need to figure it out.
    - Apertures?
    - Note: we have never seen an improvement of beam efficiency at injection with pseudo-flat lattice compared with HEP lattice even at low currents.
- Question for simulations
  - Is the flatness of the low β's more important than the high β's?
    - Are we looking at the wrong place? Fixing high β's may be less important than fixing low β's because of space charge is a lot larger when the beam is squeezed.